

**We claim:**

1. An apparatus comprising a fluid retention chamber having an opening, and a manifold comprising:

- a) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,
- b) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and
- c) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port,

the at least one opening of the output port of the manifold being in fluid connection with the opening in the fluid retention chamber,

wherein the first and second tubes define a tubing volume and the fluid retention chamber defines a retention volume,

wherein the retention volume is greater than the tubing volume,

wherein the manifold comprises only two input ports, and

wherein at least one tube has an effective diameter of at least 10  $\mu\text{m}$ .

2. The apparatus of claim 1 wherein at least one tube has an effective diameter of at least 40  $\mu\text{m}$ .

3. The apparatus of claim 1 wherein at least one tube has an effective diameter of at least 250  $\mu\text{m}$ .

4. The apparatus of claim 1 wherein at least one tube has an effective diameter of at least 500  $\mu\text{m}$ .

5. The apparatus of claim 1 wherein at least the first 30% of the first tube is dedicated.

6. The apparatus of claim 1 wherein at least the first 95% of each tube is dedicated.

7. The apparatus of claim 1 wherein the output port has first and second openings, the first opening being in fluid connection with the exit portion of the first tube, and the second opening being in fluid connection with the exit portion of the second tube.

8. The apparatus of claim 1 wherein each manifold tube has a volume of no more than 0.3 cc.

9. An apparatus comprising a fluid retention chamber having an opening, and a manifold comprising:

- a) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,
- b) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and
- c) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port,

the at least one opening of the output port of the manifold being in fluid connection with the opening in the fluid retention chamber,

wherein the first and second tubes define a tubing volume and the fluid retention chamber defines a retention volume,

wherein the retention volume is greater than the tubing volume,

wherein at least the first 30% of the first tube is dedicated.

10. The apparatus of claim 9 wherein at least the first 50% of the first tube is dedicated.

11. The apparatus of claim 9 wherein at least the first 50% of each tube is dedicated.

12. The apparatus of claim 9 wherein at least the first 75% of the first tube is dedicated.

13. The apparatus of claim 9 wherein at least the first 95% of the first tube is dedicated.

14. An apparatus comprising a fluid retention chamber having an opening, and a manifold comprising:

- a) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,
- b) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and
- c) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port,

the at least one opening of the output port of the manifold being in fluid connection with the opening in the fluid retention chamber,

wherein the first and second tubes define a tubing volume and the fluid retention chamber defines a retention volume,

wherein the retention volume is greater than the tubing volume,

wherein the output port has distinct first and second openings, the first opening being in fluid connection with the exit portion of the first tube, and the second opening being in fluid connection with the exit portion of the second tube.

15. The apparatus of claim 14 wherein 100% of each tube is dedicated.

16. The apparatus of claim 14 wherein the exit tube portions of each tube are provided as a dual lumen tube portion.

17. An apparatus comprising:

a) a manifold comprising:

- i) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,
- ii) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and
- iii) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port,

wherein each manifold tube has a volume, and

b) first and second delivery syringes, each delivery syringe having a volume, the first delivery syringe attached to the first input port, the second delivery syringe attached to the second input port,

wherein the volumes of the first delivery syringe and the first tube define a first lost volume fraction,

wherein the volumes of the second delivery syringe and the second tube define a second lost volume fraction, and

wherein each of the lost volume fractions is no more than 35%.

18. The apparatus of claim 17 wherein each lost volume fraction is no more than 20%.  
each

19. The apparatus of claim 17 wherein the second syringe contains thrombin.

20. The apparatus of claim 17 wherein the volume of thrombin in the second syringe is no more than 1 cc.

21. An apparatus comprising a fluid retention chamber having an opening, and a manifold comprising:

- a) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,
- b) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and
- c) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port,  
the at least one opening of the output port of the manifold being in fluid connection with the opening in the fluid retention chamber,  
wherein the first and second tubes define a tubing volume and the fluid retention chamber defines a retention volume,  
wherein the retention volume is greater than the tubing volume,  
wherein at least one port is visually distinctive from the remaining ports.

22. The apparatus of claim 21 wherein each port is visually distinctive.

23. The apparatus of claim 21 wherein the output port is visually distinctive from the input ports.

24. The apparatus of claim 21 wherein the first input port is visually distinctive from the second input port.

25. The apparatus of claim 24 wherein the visual distinctiveness of the input ports is achieved by color coding.

26. An apparatus comprising a fluid retention chamber having an opening, and a manifold comprising:

- a) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,
- b) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and
- c) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port,  
the at least one opening of the output port of the manifold being in fluid connection with the opening in the fluid retention chamber,  
wherein the first and second tubes define a tubing volume and the fluid retention chamber defines a retention volume,  
wherein the retention volume is greater than the tubing volume,

each port having a configuration,

wherein the configuration of the output port is different than the configuration of at least one input port.

27. The apparatus of claim 26 wherein each port has a diameter, and wherein the diameter of the output port is different than the diameter of at least one input port.

28. The apparatus of claim 27 wherein the diameter of the output port is different than the diameter of each input port.

29. The apparatus of claim 27 wherein the diameter of the output port is larger than the diameter of each input port.

30. The apparatus of claim 27 wherein the diameter of the output port is at least two times larger than the diameter of each input port.

31. A manifold comprising:

- a) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,

- b) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and
- c) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port,

each input port having a configuration,

wherein the configuration of the first input port is different than the configuration of the second input port.

32. The manifold of claim 31 wherein the second input port comprises an inner annulus and an outer annulus having an inner diameter, wherein the inner diameter of the outer annulus of the second input port is less than 1.6 cm.

33. The manifold of claim 31 wherein at least one input port comprises a luer lock fitting.

34. The manifold of claim 31 wherein each port has a diameter, and the diameter of the output port is different than the diameter of at least one input port.

35. The manifold of claim 31 wherein the first input port is visually distinctive from the second input port by color coding.

36. An apparatus comprising a fluid retention chamber having an opening, and a manifold comprising:



- a) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,
- b) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and
- c) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port,

the at least one opening of the output port of the manifold being in fluid connection with the opening in the fluid retention chamber,

wherein the first and second tubes define a tubing volume and the fluid retention chamber defines a retention volume,

wherein the retention volume is greater than the tubing volume,

wherein each port opening has a centerpoint,

wherein the three centerpoints define a triangle.

37. The apparatus of claim 36 wherein the triangle defines an output port angle  $\alpha$  of between 5 and 90 degrees.

38. The apparatus of claim 37 wherein the output port angle  $\alpha$  is between 5 and 45 degrees.

39. The apparatus of claim 37 wherein the output port angle  $\alpha$  is between 10 and 30 degrees.

40. The apparatus of claim 37 further comprising: d) a continuous base having an upper and lower surface, wherein each port is located upon the base,

41. A manifold comprising:

- a) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,
- b) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and
- c) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port, and

- d) a continuous base having an upper and lower surface, wherein each port is located upon the base,

wherein the base has a height and a width, and wherein the height of the base is less than twice the width of the base.

42. The manifold of claim 41 wherein the height of the base is less than the width of the base.

43. The manifold of claim 41 wherein the height of the base is less than the 0.5 times width of the base.

44. The manifold of claim 41 wherein the base is substantially circular.

45. The manifold of claim 41 wherein the base is integral.

46. A manifold comprising:

- a) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,
- b) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and
- c) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port, and

- d) a continuous base having an upper and lower surface, wherein each port is located upon the base,

wherein the output port extends from the upper surface of the base at an offset angle  $\delta$  leading away from the input ports.

47. The manifold of claim 46 wherein the offset angle is between 30 and 60 degrees.

48. The manifold of claim 46 wherein the upper surface between the output port and the input ports is flat.

49. The manifold of claim 46 wherein the upper surface between the output port and the input ports is convex.

50. The manifold of claim 49 wherein the offset angle is between 30 and 60 degrees.

51. A manifold comprising:

- a) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,
- b) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and
- c) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port, and

- d) an continuous base having an upper and lower surface, wherein each port is located upon the base,

wherein at least one port comprises an inner annulus, an outer annulus, and an inner surface therebetween, and the inner surface of the at least one port is beneath the upper surface of the base.

52. The manifold of claim 51 wherein the at least one port is the output port.

53. The manifold of claim 51 wherein the at least one port is an input port.

54. The manifold of claim 51 wherein the at least one port is each input port.

55. The manifold of claim 51 wherein the at least one port is each port.

56. A manifold comprising:

- a) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,
- b) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and
- c) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port, and

- d) an continuous base having an upper and lower surface, wherein each port is located upon the base,

wherein the upper surface is convex.

57. A manifold comprising:

- a) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,
- b) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and
- c) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port,

wherein the first tube has a first effective diameter and the second tube has a second effective diameter, and

wherein the first effective diameter is different than the second effective diameter.

58. An apparatus comprising:

- a) a fluid retention chamber comprising an opening and having a sterile inner surface, and
- b) a sterile orthopaedic device disposed within the fluid retention chamber.

59. The apparatus of claim 58 wherein the device is an intervertebral cage.

60. The apparatus of claim 59 wherein the cage is filled with bone particles selected from the group consisting of allograft, autograft, or demineralized bone matrix (DBM) .

61. The apparatus of claim 58 wherein the device is a fusion implant selected from the group consisting of an intervertebral cage, an intervertebral mesh device, an intramedullary rod, a screws, and a fixation plate.

62. A graft delivery chamber comprising:

- a) a tube portion comprising upper and lower ends forming upper and lower openings, respectively, the tube portion having a sterile inner wall, and
- b) a funnel portion having:
  - i) a lower end attached to the upper end of the tube portion, the lower end having a first diameter, and
  - ii) an upper end having a second diameter, wherein the first diameter is smaller than the second diameter.

63. The chamber of claim 62 further comprising a funnel lid disposed upon the upper end of the funnel portion.

64. The chamber of claim 62 further comprising a graft material disposed within the tube portion.
65. The chamber of claim 62 wherein the funnel is detachable.
66. The chamber of claim 62 wherein the tube portion further comprises an outer wall having ribs disposed thereon.
67. A graft delivery chamber having an inner wall, comprising:
- a) a tube portion comprising upper and lower ends forming upper and lower openings, respectively, the tube having a sterile inner wall, and
  - b) a plunger comprising:
    - i) a rod having a lower end, and
    - ii) a tip attached to the lower end of the rod, the tip having a radius sized to provide a circumferential seal with the inner wall of the chamber,
- wherein the tip has at least one radial transverse groove to form a transverse pore between the groove and the inner wall.
68. The chamber of claim 67 wherein the tip comprises an upper disc forming an upper flat, a lower disc, and a recessed portion therebetween.
69. The chamber of claim 67 wherein the tip comprises an upper disc forming an upper transverse throughhole, a lower disc, and a recessed portion therebetween.
70. The chamber of claim 67 wherein the transverse groove forms a helix.
71. A fluid retention chamber comprising:
- a) a tube portion comprising upper and lower ends forming upper and lower opening, respectively, the tube portion having a sterile inner wall, and
  - b) an end cap shaped to occlude at least one of the openings of the tube portion,
- wherein the end cap is attached to an end of the tube portion

72. The chamber of claim 71, wherein the cap comprises:

- i) a cylinder portion having a first and second end, and shaped to fit inside the tube portion of the fluid retention chamber, and
- ii) a disc portion attached to the first end of the cylinder and having a recess shaped to receive the outer wall of the fluid retention chamber.

73. The chamber of claim 72 wherein the cylinder portion of the end cap is threaded.

74. A manifold for providing fluid to a graft delivery tube, comprising:

- a) an output port having at least one opening,
- b) first and second input ports, each input port having at least one opening,
- c) first and second tubes, each tube having a sterile inner surface and first and second ends, and

the first end of the first tube being in fluid communication with the opening of the first input port, the first end of the second tube being in fluid communication with the opening of the second input port,

the second end of each tube being in fluid communication with at least one opening of the output port,

d) a base having an upper surface, wherein the output port is located on the upper surface of the base, and

e) a graft stand shaped upon the upper surface of the base to attach to a fluid retention chamber.

75. A connector for connecting a fluid retention chamber and a fluid delivery manifold, the connector comprising:

a) a collar portion having:

- i) a lower end portion having an outer surface shaped for attachment to an output port of the manifold, and an inner surface, and
- ii) an upper end portion having an outer surface shaped for attachment to the fluid retention chamber, and an inner surface, and



wherein the inner surface of the lower end portion and the inner surface of the upper end portion define a having thickness, the thickness having at least one transverse hole therethrough, and

b) a port portion having:

- i) a lower end portion being sterile and comprising at least one tube having an upper end and a lower end, the lower end shaped for attachment to an output port in the manifold and for fluid connection with an output opening, and
- ii) an upper end portion shaped for reception within the lower end of the collar portion and comprising an upper surface having opening in fluid connection with the upper end of the tube of the lower end portion,

wherein the upper end portion of the port portion is received within the lower end portion of the collar portion.

76. The connector of claim 75 wherein the lower end portion of the port portion comprises only one tube.

77. The connector of claim 75 wherein the lower end portion of the port portion comprises two tubes.

78. The connector of claim 75 wherein the reception of the upper end portion of the port portion within the lower end portion of the collar portion forms a mixing space therebetween.

79. The connector of claim 75 wherein the upper end portion of the port portion is shaped to be radially rotatable within the lower end portion of the collar portion between two positions by a tongue and groove mechanism.

80. A connector for connecting a fluid retention chamber and a fluid delivery manifold, the connector comprising:

- a) an upper end shaped for attachment to the fluid retention chamber, the upper end being sterile and comprising an inner surface comprising a breachable skin for extension of a tube therethrough, and

b) a lower end, the lower surface being sterile and shaped for attachment to an exit port of the manifold and exposing the breachable skin.

81. The connector of claim 80 wherein the upper surface has an outer annulus shaped for reception of the fluid retention chamber.

82. The connector of claim 80 wherein the breachable skin comprises at least one slit.

83. Graft forceps suitable for handling gelled graft, comprising:

c) a first tyne having i) a lower end forming a first arcuate shape having a sterile inner surface, and ii) an upper end, and

d) a second tyne having a lower end forming a second arcuate shape having a sterile inner surface, and ii) and an upper end,

wherein the upper ends are connected,

wherein each arcuate length has a length and a diameter

and wherein the length of each arcuate shape is at least two times its diameter.

84. The manifold of claim 83 wherein the length of each arcuate shape is at least two times its diameter.

85. An apparatus comprising a fluid retention chamber having an opening, and a manifold comprising:

a) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,

b) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and

c) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port,

the at least one opening of the output port of the manifold being in fluid connection with the opening in the fluid retention chamber,

wherein the first and second tubes define a tubing volume and the fluid retention chamber defines a retention volume,

wherein the retention volume is greater than the tubing volume,

wherein the output port of the manifold has a male luer fitting, and the fluid retention chamber has a female luer fitting.

86. A method of use comprising the steps of :

a) providing an apparatus comprising a fluid retention chamber having an opening, a pair of delivery syringes containing two dissimilar liquids, and a manifold comprising:

- i) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,
- ii) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and
- iii) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port,

the at least one opening of the output port of the manifold being in fluid connection with the opening in the fluid retention chamber,

wherein the delivery syringes are respectively attached to the input ports to provide fluid connection between the input port openings and the syringe openings,

b) flowing the liquids from the delivery syringes through the manifold tubing and into the fluid retention chamber, wherein the fluids mix in the fluid retention chamber, and

c) flowing the mixed liquid from the fluid retention chamber through the manifold and into at least one of the delivery syringes.

87. The method of claim 86 wherein step c) is accomplished by creating a vacuum in the at least one delivery syringe.

88. A method of use, comprising the steps of :

a) providing an apparatus comprising a fluid retention chamber having an opening, a pair of delivery syringes containing two dissimilar liquids, and a manifold comprising:

i) an output port adapted for attachment to a fluid retention chamber, the port having at least one opening,

ii) first and second input ports, each port adapted for attachment to a delivery syringe, each input port having an opening, and

iii) first and second tubes, each tube having a sterile inner surface, and entry and exit portions,

the entry portion of the first tube being in fluid communication with the opening of the first input port, the entry portion of the second tube being in fluid communication with the opening of the second input port,

the exit portion of each tube being in fluid communication with the at least one opening of the output port,

the at least one opening of the output port of the manifold being in fluid connection with the opening in the fluid retention chamber,

wherein the delivery syringes are respectively attached to the input ports to provide fluid connection between the input port openings and the syringe openings,

b) flowing the liquids from the delivery syringes through the manifold tubing and into the fluid retention chamber, wherein the fluids mix in the fluid retention chamber, and

c) fluidly connecting the mixed fluid in the fluid retention chamber and a treatment site on a patient, and

d) injecting the mixed fluid into the treatment site.